Cloud Computing: A Key to Effective & Efficient Disease Surveillance System

Sunil Chowdhary and Abhishek Srivastava
Department of IT, ASET
Iitg.sunil@gmail.com; Abhishek.sri13@gmail.com

***Abstract*— Cloud computing, a future generation concept characterized by three entities: Software, hardware & network designed to enhance the capacity building simultaneously increasing the throughput by extending the reach for any system without having heavy investment of infrastructure and training new personnel. It is becoming a major building block for any sort of businesses across the globe. This paper likes to propose a cloud as a solution for having an effective disease surveillance system. Till now, multiple surveillance systems come into play but still they lack sensitivity, specificity & timeliness.**

Keywords- Cloud, Disease, Surveillance system, Service

I. Introduction

For each developed or developing country, total economy relates with the human capital [1] and its strength lies on two pillars: Education & Health. In the era of economic competition, education becoming important source of competitive advantage and a process to attract jobs and investment while business rely on peoples for their operations and success. Therefore, good health among employees enables businesses to grow and keep a competitive edge.

In past decade, several costly threats of infectious diseases like bird-flu, HINI, Severe Acute Respiratory Syndrome (SARS) epidemic in Asia, the outbreak of avian flu in East Asian countries, the catastrophic after effects of Hurricane Katrina in New Orleans in 2009, and anthrax attacks in the US in 2001 leave a huge impact on humanity or human capital by claiming hundreds of the human lives. Infectious disease outbreaks, whether naturally occurring or intentionally designed, represent threats to human health and national security.

To Combat outbreak of major infectious disease, increasingly international cooperation with access to surveillance information & compliance to international health regulations is strongly needed. Several measures have been practiced for decades and still continue to be a requisite. A surveillance system [2] should have the objective to issue early alarming signals, so that appropriate timely steps can be taken to curb the epidemic. Traditional system found to be more time consuming as it includes less efficient data collection & and monitoring activities, arduous laboratory diagnosis and incapable notifying medium.

But commencement of ICT [3] acts as a boom and provides a platform to speed up the process of detection of disease outbreaks. Information communication technologies (ICT) emerged as a big supporter of human and acquired a sufficient space in their life. Almost all the activities of human daily life are not accomplished without interventions of ICT. Businesses like railways, water supply, banks, governance [5], telecommunications, and healthcare also relying on ICT to automate their work for extending their reach-ability & networks [4] in social and economic development.

New ICT based systems can provide valuable and timely information to the health officials using intelligent systems, databases, hi-tech analytic techniques like data mining, modeling, visualization, ontology mapping etc. These advances enable public-health surveillance systems capability of real-time or near real-time detection of epidemic and potential opposition to exposure of bioterrorism and allowing for a rapid public-health response.

II. Related Works

In recent years, several surveillance approaches [6][7] proposed by researchers. According to the study conducted, in 2003 approximate 100 sites implemented and deployed by US alone throughout country for disease control and precaution. Some of the disease surveillance system which already implemented listed as below and many more to follow.

- Real-Time Outbreak and Disease Surveillance system (RODS) began in 1999 at the University of Pittsburgh for the purpose of detecting the large-scale release of anthrax.
- BioStorm (Biological spatio-temporal outbreak reasoning module) has been developed at the Stanford Center for Biomedical Informatics Research in collaboration with McGill University is to develop fundamental knowledge about the performance of aberrancy detection algorithms used in public health surveillance.
- National Electric Disease Surveillance System (NEDSS) initiated by Public Health Information Network (PHIN) to promote the use of data and information system standards to advance the development of efficient, integrated, and interoperable surveillance systems at federal, state and local levels in US.
- BioPortal (2003) an infectious disease surveillance system came into existence as a joint effort of University of Arizona Artificial Intelligence Lab, New York State Department of Health, California Department of Health sponsored by US National Science Foundation, the Department of Homeland Security, the Department of Defense, the Arizona Department of Health Services,

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and Kansas State University's BioSecurity Center etc.

- BioSense is a CDC (Centers for Disease Control and Prevention) initiative released in 2004.
- HealthMap (2006) is a freely accessible web site that integrates data from electronic sources, and visualizes the aggregated information onto the world map, classified by infectious disease agent, geography, and time which aims to deliver real-time information for emerging infectious diseases.

Till available systems gain world wide acceptance, serve their purposes up to many folds but some discrepancies mentioned below makes them fruitless:

- False Alarm: Difficulties in identifying natural variation from original outbreak rise to generation of false alarm.
- Efficient use of system: System can't be realized if epidemic spread quickly (target many in short span of time) or infect only few.
- Low quality and clumsy data.
- Less efficient data collection process.
- System Interoperability: Absence of standard vocabularies and messaging protocols leads to system interoperability problems among syndromic surveillance systems and the underlying data sources.
- Algorithm Benchmarking and Comparison: Each system implements a unique algorithm for detection purpose. Need to find out the strengths and drawbacks of each and try to coordinate the efforts.
- Assessment, Evaluation, and Deployment.

III. Cloud Computing

Cloud computing, an emerging ICT technology based on internet help in providing services & resources within users over a globe. It helps in reliving the organizations from huge investment on software, hardware & resources by visualizing the resources through which consumers and businesses can access personal files and application without installation at any computer simultaneously significant workload shift by transferring the services on the network of computers that make up the cloud. Cloud computing visualized [8] as:

1) Virtualization (scalable and partitioned infrastructure)
2) Computation (Grid computing, distributed computing etc)
3) Connectivity (Web 2.0 web application framework)
4) Architecture (Service oriented Architecture)
5) Services (Software as a Service, Infrastructure as a service, Platform as a service, Hardware as a service)

IV. Why Cloud Computing For Disease Surveillance System

A. System CapacityBuilding:

Effective system needs creation of an environment that fosters technology-enabled improvements to existing systems and delivery, including organizational, policy, and technical interventions. The most biggest challenges is the growing demands for and shortages of qualified, trained health care professionals and training resources to track and detect the spread of epidemic effectively.

By simple scanning of the doctor's prescription slip, information about patient disease and prescribed medicine can easily gather & collected at the database. Cloud enables monitors or trackers use the company's (hospitals, clinics) remote ehealth archive services to gain access to that data of every single patient by any authorized user anywhere in the world through a simple internet connection (cloud connectivity services). This service provides cost-effective data sharing and collaboration among healthcare providers, imaging centers, radiologists, referring physicians, and other clinicians or staff in no time. This collaborative data sharing provide a base for detection by providing the newly symptoms for any breakdown or expanded epidemiologic capacity to investigate and mitigate outbreaks of epidemic. Thus, capacity building can helps in curb the false alarm rate.

B. Central Observatory:

Observatory intended to be a platform for sharing information and capacity building to improve health workforce development by providing member states with strategic information and guidance on effective practices, policies and standards in healthcare like East, Central and Southern African Health Community (ECSA) [9], South East Public Health Observatory (SEPHO) [10].

Through cloud Visualization and Computation, observatory team will able to deduce the latest research information related with outbreak of any epidemic, new or early symptoms, ways to tackle such outbreak and simultaneously disseminate information rapidly to public health advisories to the news media and the public. Using observatory repositories or libraries, low quality or clumsy data can be enriched to standards which enable effective detection in case of few cases only by supporting exchange of information on a 24*7 basis.

Although central observatory [11][12] and their subsidiaries ensure secure electronic data exchange between public health partners, computer systems by protection of system (data, information, and services) with adequate backup within organizations, and surge capacity to respond to bioterrorism and other public health threats and emergencies.

C. Inter-Operability using Universal Standards:

Absence of standards vocabulary and system interoperability problems among syndromic surveillance systems tends to be the biggest hurdle. Each clinical working application built using heterogeneous medical platforms and forced them to rely on particular version. In that case sticking to the same heterogeneous platform is a necessity rather than a choice unless a platform exist which provide a mapping between various heterogeneous platforms, programming or scripting languages.

Here, existence of intelligence services (PaaS, IaaS, and SaaS) and Service oriented Architecture within cloud to detect underlying frame-work within the test application and mapping

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of frameworks by deployment of the relevant components against client's request provides an alternative to resolve the inter-operability issue within the system.

C. Education and Training:

Now a day's most of the countries rely on the cloud for leveraging education & efficiencies across the nationwide or statewide school network as they suffer from low graduation rates directly attributable to insufficient infrastructure like shorthanded staff, tiny classrooms, lack of teacher etc. These problems can be surmounted through virtual classrooms where hundreds of children can attend the class while sitting at their homes, with the teacher present miles away. In the same fashion employing cloud services in health care [13] can act as a boost to us.

Using same approach, general information consisting protective measures, precautions & detection against epidemic outbreak can be propagated to the remote areas by academic institutions, healthcare [14][15] professionals, & other sources.

V. Conclusion And Future Work

Cloud computing can help us to curb the above mentioned challenges and provide a platform for laying the foundation of such effective system capable to track the outbreak of any epidemic at very early stages by providing knowledge information sharing among researchers, clinical institutions, hospitals, pathology labs and government health care bodies.

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